viewers on the given storage device 110 may be expressed as the product of the Skew value and the number of viewers per device given even demand distribution, or (1.4 * 100) = 140 viewers.

It will be understood with benefit of this disclosure, that performance of storage system 100 may be impacted by a number of other factors that may exist in multi-storage device environments, such as striping, replica, file placements, *etc.* It will also be understood that although at least one of such factors may be considered if so desired, this is not necessary in the practice of this exemplary embodiment of the disclosed methods and systems which instead may employ calculated performance characteristics such as AA and the TR to reflect aggregated and logical I/O resource capacity.

Storage device I/O capacity may be represented or otherwise described or quantified using, for example, a combination of NoD, AA and TR values, although it will be understood with benefit of this disclosure that I/O capacity may be represented using any one or two of these particular values, or using any other value or combination of these or other values, that are at least partially reflective of I/O capacity. Likewise, in the practice of the disclosed methods and systems, storage processor memory allocation may be represented or otherwise described or quantified using any value or suitable memory model that is at least partially reflective of memory capacity and/or memory allocation structure.

In one embodiment of the disclosed methods and systems, an integrated logical memory management structure as previously described herein may be employed to virtually partition the total available storage processor memory ("RAM") into buffer memory, cache memory and free pool memory. In such an exemplary implementation, the total available storage processor memory may be logically partitioned to be shared by cached contents and read-ahead buffers. Among the total RAM, a maximum cache memory size ("M_CACHE") and minimum free pool memory size ("MIN_FREE_POOL") may be designated. In this regard, M_CACHE represents maximal memory that may be employed, for example by cache/buffer manager 130 of FIG. 1, for cached contents. MIN_FREE_POOL represents minimal free pool that may be maintained, for example by cache/buffer manager 130. Further information on the concept of MIN_FREE_POOL may be found in United States Patent Application Serial No. 09/797,201

SURG-156

filed on March 1, 2001 which is entitled SYSTEMS AND METHODS FOR MANAGEMENT OF MEMORY IN INFORMATION DELIVERY ENVIRONMENTS and which has been incorporated herein by reference.

5

Resource Modeling for Single Storage Device in Balanced or Substantially-Balanced
Workload Environments

In one exemplary embodiment of the disclosed systems and methods, a resource model
10   approach to how viewers are served for their I/O demands from one storage device element (*e.g.,* a single storage disk) may be taken as follows, although it will be understood that alternative approaches are also possible. In this exemplary implementation, a cycle time period ("T") may be taken to represent the time during which each viewer is served once, and in which a number of bytes ("N") (*i.e.,* the "read-ahead size") are fetched from a storage device. Assuming that
15   there are NoV viewers with each viewer i to fetch N_i number of blocks, the storage device service time for each viewer may be formulated in two parts: 1) the access time (*e.g.,* including seek and rotation delay); and 2) the data transfer time. Viewers may be served in any suitable sequence, however in one embodiment employing a single storage device element, multiple viewers may be served sequentially.

20

When the current embodiment is employed for I/O operations in multimedia applications, it may be desirable to ensure continuous playback, *i.e.* to ensure that there is always sufficient I/O capacity as well as sufficient data contained in the buffer to be played out. In one exemplary embodiment, continuous playback may be ensured by making sure that data consumption rate for
25   each viewer i ("P_i") multiplied by cycle time period T is approximately equal to block size BL multiplied by fetched number of blocks N_i for the viewer i:

$$N_i * BL = T * P_i \qquad (1)$$

For continuous playback, cycle time T should be greater than or equal to the storage device service time, *i.e.*, the sum of access time and data transfer time. Under operating conditions, actual access time may be hard to quantify, and therefore may be replaced with average access AA, a value typically provided by storage device vendors such as disk drive vendors. However, it is also possible to employ actual access time when this value is available. Data transfer time may be calculated by any suitable method, for example, by dividing average transfer rate TR into the product obtained by multiplying number of bytes fetched N_i for each viewer by block size BL. Alternatively, data transfer time may be calculated under continuous playback conditions described above by dividing average transfer rate TR into the product obtained by multiplying data consumption rate for each viewer i ("P_i") by cycle time period T. Accordingly, in one embodiment cycle time T may be calculated to ensure sufficient I/O capacity for continuous playback for a number of viewers by using the following formula:

$$T \geq NoV * AA / [1 - (\Sigma_{i=1}^{Nov} P_i) / TR] \tag{2}$$

Assuming no buffer sharing savings and that each viewer will not start to play back until all N_i blocks are fetched, sufficient buffer data for continuous playback may be ensured by making sure that total available buffer space B_{max} is greater than or equal to the product obtained by multiplying number of bytes fetched N_i by the block size BL. Alternatively, sufficient buffer data for continuous playback may be ensured by making sure that total available buffer space B_{max} is greater than or equal to the product obtained by multiplying data consumption rate for each viewer i ("P_i") by cycle time T. Accordingly, in one embodiment cycle time T may be calculated to ensure sufficient total available buffer space to allow continuous playback for a number of viewers by using the following formula:

$$T \leq B_{max} / (\Sigma_{i=1}^{Nov} P_i) \tag{3}$$

The disclosed methods and systems may also be employed with information management I/O systems that use buffer sharing techniques to reduce buffer space consumption. In one